Salmon Farming on the Sunshine Coast

A Summary of Achievements & Problems 1985-1986

Information Report #8

Ministry of Agriculture and Fisheries
Aquaculture and Commercial Fisheries Branch

SALMON FARMING ON THE SUNSHINE COAST - SUMMARY OF ACHIEVEMENTS AND PROBLEMS, 1985-1986[1]

BY

L. MICHAEL COON

Information Report #8, Marine Resources Section, Commercial Fisheries Branch, Ministry of Agriculture and Fisheries

---

[1] Presented at the 3rd Annual Sunshine Coast International Aquaculture Conference, September 3-6-, 1986.

Canadian Cataloguing in Publication Data

Coon, L. M., 1946-

Salmon farming on the Sunshine Coast - summary of achievements and problems, 1985-1986

(Information report / Marine Resources Section, ISSN 0832-8226 ; #8)

"Presented at the 3rd annual Sunshine Coast International Aquaculture Conference, September 3-6, 1986."

ISBN 0-7726-0579-3

1. Salmon. 2. Fish-culture - British Columbia - Sunshine Coast. I. British Columbia. Marine Resources Section. II. Title. III. Series: Information report (British Columbia. Marine Resources Section) ; no. 8.

SH167.S17C66 1986 639.3'755 C86-092205-7

SALMON FARMING ON THE SUNSHINE COAST - SUMMARY OF ACHIEVEMENTS AND PROBLEMS 1985-1986

L. Michael Coon, Marine Resources Section, Commercial Fisheries Branch, Ministry of Agriculture and Fisheries, 780 Blanshard Street, Victoria, B.C. V8V 1X5 (387-9684).

INTRODUCTION

Beginning in August, 1985, Marine Resources Section staff began annual visits to active salmon farm sites to carry out diligent use assessments, gather such production information as growth and survival rates achieved, use of such husbandry practices as sexual modification of fish stocks and to ascertain the types and severity of environmental and water quality problems. Anecdotal data obtained from contributing salmon farmers for the period June 1985 - mid August 1986 are summarized in this presentation. My intent is to provide a snapshot of the achievements and problems encountered in this first year of major salmon farming activity on the Sunshine Coast.

All active farm sites in the Sunshine Coast area were visited during the first half of September 1985 and again in mid-August 1986. I wish to acknowledge the contributions of John Arber, Ed Black, Stafford Reid and Linda Hall to the collection of data and of Susan Billings, Ken Lozoway and, particularly, John Arber for their able assistance in massaging the data into presentation format.

INDUSTRY SIZE AND PRODUCTIVE CAPACITY

I estimate that, as of 26 August, 1986, there were 73 salmon farms operating in British Columbia; 32 of these (41.6%) were in the Sunshine Coast

area (Table 1). The number of operating farms Province-wide has roughly doubled from last year and the Sunshine Coast area has maintained its proportional representation. However, a trend of decreasing percentage of sites still under application, suggests that available and biophysically attractive sites are in increasingly short supply in the Sunshine Coast area.

In August 1986, the 32 active salmon farms had an occupied net pen volume (i.e. the volume of net pen which housed fish) of over 272,000 m^3 - a 170% increase over that noted in Sunshine Coast salmon farms in September 1985 (Table 2). The tonnage holding capacity of these occupied net pens, assuming a density of 8 kg/m^3, amounts to over 2,165 tonnes. Additionally, a number of farms had unused net pens on site. The total holding capacity, including the unused net pens, would be over 2470 tonnes. Note that the average occupied net pen volume per site is 8,505 m^3 - just over the volume permitted in Norway - but ranges as high as 51,000 m^3, or over 6 times that permitted in Norway. If we were to include the vacant net pens, the average holding capacity per site was over 85 tonnes and ranged as high as 405 tonnes.

SMOLT SUPPLIERS

A salmon farm production cycle starts with the delivery of smolts. The data given in Table 3 indicate that the number of smolt producers supplying Sunshine Coast salmon net pen sites increased from four in 1985 to 11 in 1986. Cockburn Bay Sea Farms Ltd. was by far the largest smolt supplier in both years, but a trend of increasing supply from Vancouver Island smolt producers is evident. At least two new salmon hatcheries, initiated in the survey area in the fall of 1985, supplied smolts in 1986.

FISH NUMBER, WEIGHT AND MORTALITY ESTIMATES

We were able to get useful estimates of fish numbers, weights and mortality from 30 of 32 active farm sites. Readers should be aware that the accuracy of estimates reported probably varies widely--some respondents

consulted their memories while others consulted their daily or monthly logs. At any rate the estimates given below should only be considered for their value in indicating general trends or guidelines. Even so, they represent a unique body of information on growth and mortality of salmon based on the experience of commercial salmon farmers, as opposed to most publicly available data which derive from experimental husbandry protocols which may differ from those employed by salmon farmers.

Table 4 provides a summary of the numbers of fish, by species and year class, reported on hand by Sunshine Coast salmon farmers as of mid-August, 1986. The total number is nearly triple the 1.25 million reported on hand as of mid-September, 1985. The number of chinook salmon reported was approximately double that reported in 1985, while the number of coho was over three times and the number of rainbow trout was nearly nine times those reported in 1985. Atlantic salmon smolts were introduced to British Columbian coastal waters for commercial farming purposes for the first time in 1986. The values given in Table 4 are underestimates in many species/year class categories, since some respondents were not able to estimate the number of fish on hand at the time of our visit. Tables 5, 6 and 7 provide estimates of average fish weight and number on hand at specific dates for smolts in their first year in seawater (0+), fish in their second (1+), third (2+), fourth (3+), and fifth (4+) years in seawater, organized by species and sexual modification (for lack of a better term). Mortality estimates are also given.

In 1985 the majority of chinook and coho smolts were stocked between mid-June and mid-July (Table 6) while this year fish were still being tranferred to sea pens in mid-August (Table 5). Perhaps this reflects the cooler water temperatures experienced this year compared to last year's abnormally high near-surface temperatures. It also probably results from logistical difficulties experienced in securing a Lease or Licence of Occupation, financing, net pens etc. earlier in the season. It will be

interesting to see if smolts stocked so late in the summer will result in smaller fish one year hence. Because the stocking period this year extended right to our survey date, there is not much difference between the lowest weights recorded for chinook and coho salmon at stocking and at mid-August (Table 5). However, the average weights for these species showed at least a threefold increase in this same period. Average weight for late spring and summer transplanted rainbow trout only increased about 35% by mid-August, while January-February stockings had increased in average weight by 1400% by the survey date.

Sterile coho appear to grow more slowly than natural coho; this is evident both in their early ocean residence (Table 5) and at the end of their first full year in seawater (Table 6). In fact, their weight may be half that of natural coho of equal age. Sterile coho had a slightly higher average overall mortality then natural coho during the first several months of ocean residence, but a 7% lower mortality in the 11 months from mid-September 1985 to mid-August 1986. A total of 95,000 feminized coho were stocked at three farm sites this year--this, I believe, is a first for British Columbia. In terms of weight gain and percent survival, these feminized coho approximated the natural coho to the date of our survey. The outstanding performance in weight gain by one group of cohos which were raised for a full year or more in freshwater suggests that any added costs of such smolts would be well worth the investment. These fish grew from 10 gm in May 1985 to 4500 gm by mid-August, 1986--about double the rate of average "accelerated" coho!

Mean body weights for feminized chinook salmon in Tables 5, 6 and 7 suggest that these sexually modified fish in the 0+, 1+ and 2+ age classes grow 20-40% slower than do natural chinook of equal age. That the feminized 3+ fish are equivalent in mean weight to 3+ natural chinook may be due to the small sample size. Data estimates given in Tables 5 and 6 suggest that feminized 0+ and 1+ chinooks experience 50-60% lower mortality than do natural chinooks of

the same age classes. However, this balance shifts to near equivalence with 2+ and 3+ fish. Again, the low sample size for the older fish warns against placing too much "weight" on this observation. If the estimates given above for weight and mortality of 0+ and 1+ feminized chinook approximate reality, then their increased survivorship should more than compensate for their slower growth rate. What may be the Province's first batch of 20,000 sterile chinook smolts was transferred to one Sunshine Coast farm site in mid-August, 1986. We will watch the performance of these fish with great interest.

Natural rainbow trout transferred to seawater in late spring to early summer, 1986 attained a mean weight similar to natural chinook and coho by mid-August but, since they started at a greater weight, apparently grew slower (Table 5). As noted earlier, it would appear that a better strategy for rainbow would be to transfer smolts to seawater in the winter months. The literature suggests that rainbow grow faster in waters of estuarine salinities. Because of heavy winter precipitation followed by the spring freshet of snow melt waters in the Jervis Inlet system, winter transplanting of rainbow to seawater will ensure a longer period of more optimal salinity. Natural rainbow put in seawater in 1985 attained an average weight by mid-August 1986 which was 30-35% greater than natural chinook and sterile coho transferred to seawater that same year. However, despite having a 18.5% greater mean weight in September 1985, these natural rainbows attained a mean weight 17% less than natural coho by August 1986. A single group of sterile rainbow attained a range in weight similar to sterile coho. The most striking aspect of the statistics on rainbow is the high mortalities experienced. Percent mortality of rainbow transferred to seawater in 1986 was four times that of any other species/sexual modification category for the same period. For 1+ fish the overall mortality was 50-82%, and one farm reported a 100% mortality.

SEXUAL MODIFICATION

About 22% of the chinook smolts stocked in 1986 were feminized, down from about 33% in 1985 (Table 8). Two percent of chinooks were sexually sterilized this year; none were last year. Fully 62% of coho smolts stocked this year were sterilized and 5% were feminized. In 1985 only 25% of coho smol s were sterilized. This is the first year that feminized coho have been available to Sunshine Coast salmon farmers and indicates an interest in developing domesticated coho broodstock. Feminization should also avoid jacking losses in 0+ coho and 1+ chinooks. Sterilization is aimed at eliminating losses due to sexual maturation and attaining a greater flexibility in harvest strategy.

VACCINATION

It appears that almost all smolts transferred to seawater in the Sunshine Coast area this year were vaccinated against vibriosis; one half to two thirds of the farms reporting on vaccination also noted vaccination against furunculosis (Table 9). This is the first year that vaccination of smolts against furunculosis has been practised in British Columbia on a commercial basis. Some farms reported that certain of the stocks purchased had been dip vaccinated two and even three times, in all cases to confer immunity against both vibriosis and furunculosis. That losses of vaccinated fish have been attributed to vibriosis in both 1985 and 1986 suggests that immunity was not completely conferred with single dip vaccination. This is consistent with published reports which suggest that the protection rate could be as low as 60% with a single dip vaccination. I assume that repeating the dip vaccination process two and three times is an attempt to ensure conference of near 100% immunity. Fish so treated will bear careful observation to see if this procedure is effective. Another possible explanation for losses of vaccinated fish which are attributed to vibriosis is that the currently available vaccines, which offer protection from Vibrio anguillarum and V. ordalli, simply do not protect against other, previously unrecognized but pathogenic Vibrio biotypes which are endemic in local waters.

BIOLOGICAL AND ENVIRONMENTAL PROBLEMS ENCOUNTERED

Disease

Disease losses were reported at all farm sites in the Sunshine Coast area in the eleven months from mid-September 1985 to mid-August 1986. Even those which had only been operating for one to two weeks reported post-transfer losses of smolts which they attributed to vibriosis. Such losses were generally low, usually less than 2%, but some farms reported post-transfer losses as high as 5.6% for coho, 10% for rainbow and 32% for chinook. Post-transfer losses are those which take place within two weeks of smolt transfer to seawater net pens. It is generally assumed that the stress of transportation and handling, together with the stress associated with dumping smolts into seawater of different temperature and/or salinity than that to which they were acclimated, results in the smolts being more susceptible to ubiquitous pathogenic Vibrio's. Percent losses given below should not be construed as occurring on all farms; rather they represent estimates of loss attributed to specific causes on farms where the losses occurred.

Vibrosis outbreaks subsequent to the post-transfer period were reported to result in losses of 0+ chinook ranging from <1-42% and in older chinook year classes ranging from 9-20%. Vibriosis losses were reported responsible for losses of 20-30% of 0+ rainbow trout. Salmon farmers countered vibriosis outbreaks with treatments of sulphamerazine or a sulphamerazine/terramycin (oxytetracyclin) mix. Hopefully, we will find that the multiple dip vaccination protocol will confer near total immunity to 0+ fish against vibriosis.

In many cases, salmon farmers were not able to distinguish losses due to vibriosis and bacterial kidney disease (BKD). Losses from the two diseases combined were reported to range from 7.5-50% for 1+ or older chinook and from 5-50% for 1+ coho. However, for 1+ coho the median reported loss was only 5% from mixed vibriosis/BKD.

One farm reported a 4% loss of 1+ coho due to BKD. For 1+ and older chinook salmon, reported losses attributed to BKD ranged from 11-35%. Hopefully, the disease screening program initiated last fall will eliminate vertical transmission of BKD. This should result in dramatically lower losses to this disease, but great care should be taken to avoid mixing screened and unscreened stocks. We will have a measure of the success of the 1985 screening program over the winter of 1986-87.

Myxobacterial infections were also reported to cause losses to 0+ rainbow trout of 2 and 10% at two farm sites and were implicated in unquantified "cold water disease" losses in 1+ chinooks at a third farm. At yet another farm, myxobacterial infections, Chaetocerus blooms and sea lice infestations combined to kill 50% of 0+ rainbow over the winter of 1985-86. A sulphamerazine/ terramycin mix was reported used for treatment of myxobacterial infections.

One farm reported mortalities in its 1+ rainbow which were attributed to nephrocalcinosis, a non-infectious disease resulting from excessive calcium in the diet. Better diet formulations should completely eliminate this problem.

Predation

Predation losses were reported to be nil or very low (1% or lower) on all farms in the Sunshine Coast area. However, infrequent attacks by dogfish, seals, otter and marten have resulted in mortalities both directly (fish being eaten) and indirectly. Indirect causes include wounding which leads to death from secondary infection, and escapement through holes torn in the net pens. On one farm I noticed severe scale loss in the head region of a large number of 1+ salmon which resulted from their attempts to escape through a hole or holes chewed in the net by predators. Such scale loss provides sites for infection and certainly lowers the market value of these fish. Predator attacks are stressful to the fish and in several instances we were told that the fish would not eat for several days after an attack. The only way to protect against aquatic predator losses is to use predator control devices such as heavy webbing envelopes and so called "sharkguard" double bottoms on net pens.

Regular inspection of nets for holes and frequent removal of dead fish are essential mitigation procedures--fortunately, they are widely practised in the Sunshine Coast. Otter, marten and mink are deterred by electric fences, guard dogs and netting stretched over the top of net pens. In the latter use, this netting is most effective if sewn to the production netting.

Herons, kingfishers and sea gulls appear to be more of a nuisance than a serious problem. Most of the fish they succeed in capturing were sick, young and/or of such species as perch and rockfish which inhabit the net pen area.

Plankton Blooms

A Chaetocerus bloom observed in Sechelt Inlet and Agamemnon Channel in late September 1985 was reported to cause losses of rainbow trout as high as 80% of 1+ stock but had no apparent effect on chinook and coho. A Chaetocerus bloom which was occurring at the time of our survey in mid-August was reported to have killed 37% of 0+ coho smolts at one Sechelt Inlet site.

A Heterosigma bloom which occurred in late June 1986 caused high mortalities amongst rainbow, chinook and coho stocks in affected areas of the Sunshine Coast. Rainbow trout appeared most susceptible, suffering reported mortalities of 60-100% in 0+ fish and 43% amongst a single 1+ stock. Chinook percent mortalities were highest amongst oldest age classes and, in most instances, were progressively less with younger age classes. Thus losses of 42% losses of 4+ fish, 20% of 3+ fish and only 3% of 2+ fish were reported at one farm. No losses of 0+ chinook stocks were reported, although one farm lost 15% of its 1+ stock. Coho appeared to be less susceptiable to the effects of this dynoflagellate bloom. Reported losses were confined to 1+ stocks (perhaps because most 0+ fish had not yet been transferred to seawater) and ranged from 2.5-33%.

Methods to mitigate against farmed fish losses due to the effects of phytoplankton blooms are few at present, and those that do exist are not panaceas. This area warrants much further study.

Poor Quality Smolts

Both new and more established members of the industry expressed their dismay at the poor quality of some smolts, particularly coho, delivered to net pen sites. At least seven respondents noted mortalities amongst 0+ coho as occurring predominantly amongst "non-smolts", "pinheads", and fish suffering other deformities. Losses attributed to smolts in their first summer in saltwater ranged from 1-14%. Deformities are largely the result of sterilization. A study is underway to develop a commercial scale sterilization procedure which will reduce the incidence of deformed fish (Linda May, pers. comm.). Additionally, it appears that most of the "non-smolts" which succumb in the early months of ocean residence are those which are smallest when transferred to seawater. It has been suggested that smolt producers would be able to supply larger smolts if they could get eggs from early runs of parent broodstock.

Losses attributed to chinook "non-smolts" were reported on only two farms. Mortalities were 1 and 10.5% and both stocks were natural chinook. The 1% mortality occurred with 0+ fish and the 10% loss with 1+ stock.

SUMMARY

1. The salmon farming industry in the Sunshine Coast area nearly doubled in size since 1985, with 32 operating farms in 1986. Applications for additional sites suggest that another 30 salmon farms will exist in the area by 1988.

2. The average farm had over 8,000 m^3 of occupied net pen volume in August 1986; at a density of 8 kg/m^3 the holding capacity of all net pens in the Sunshine Coast area amounts to over 2,700 tonnes.

3. Over 3.3 million chinook, coho, rainbow trout and Atlantic salmon were held in net pens in the survey area in August 1986--up nearly three times over the 1.25 million at this time last year.

4. Growth and mortality schedules are being constructed based on the experience of commercial salmon farmers in the Sunshine Coast area. These will be useful to newcomers, insurance companies, financial institution, government agencies and as yardstick against which established farmers may measure their performance.

5. The industry continues to experiment with sex modification practices to improve survival, economic efficiency and to increase egg production and flexibility in harvest strategy.

6. Cumumlative disease losses in the Sunshine Coast area were generally less than 5% for chinook and coho in the early months of ocean residence, reached 15-30% by the fall of the second year in seawater, and about 35% by the third fall in seawater. Rainbow losses were higher--over 50% by the fall of the second year in seawater.

7. New vaccination protocols and new vaccines are being tested in an attempt to reduce losses due to disease. The disease screening program for broodstock should reduce future losses to BKD.

8. Predation losses in the survey area have been low to date, but constant vigilance and use of prevention methods are suggested to ensure that this record remains intact.

9. Losses to plankton blooms in the Sunshine Coast area have been very high in affected areas. Kills of broodstock were particularly damaging. Steps must be undertaken to ensure that fish farmers are warned of potential bloom situations and mitigation practices must be developed, tested and applied when needed.

Table 1. Comparison of salmon farms sites, both operating and under application, in British Columbia as a whole and in the Sunshine Coast area in 1985 and 1986 (source: Marine Resources Section files).

	As of October, 1985		As of 26 August, 1986	
	British Columbia	Sunshine Coast	British Columbia	Sunshine Coast
No. operating farms	37	17	73	32
No. approved sites[1]	36	17	67	22
No. sites pending approval[2]	54	16	109	11
No. sites recommended for Section 10 Licence[3]	NA	NA	104	12
Totals	127	50	353	77

[1] Salmon Farm Management Plans (SFMP) approved by Marine Resources Section (MRS), but farms not yet operating.

[2] SFMP's accepted for review but not yet approved.

[3] Recommended by MRS for a Section 10 Licence.

Table 2. Comparison of net pen volume and holding capacity of Sunshine Coast salmon farms in 1985 and 1986. NA= not available.

	Occupied Net Pen Volume (m^3)		Holding Capacity (t) of Occupied Net Pens at Density of 8 kg/m^3		Capacity (t) of Occupied Plus Vacant Net Pens at Density of 8 kg/m^3	
	1985	1986	1985	1986	1985	1986
Mean	NA	8,505	NA	67.6	NA	85.7
Range	680-14,860	227-51,120	5.4-118.9	1.8-404	NA	3.6-405.4
Total	100,035	272,176	800	2,165	NA	2,744

Table 3. Number of salmon farms in the Sunshine Coast area supplied with smolts by various smolt producers in 1986, by species. Asterisks denote those producers who supplied smolts to Sunshine Coast farm sites in 1985 (not necessarily the same species as in 1986).

Smolt Producers	Chinook	Coho	Rainbow Trout	Atlantic Salmon
*Cockburn Bay Seafarms Ltd.	18	19	4	0
*Pacific Aqua Foods Ltd.	2	1	1	1
Western Aquaculture Resources Ltd.	3	4	0	0
*Sea Spring Salmon Farms Ltd.	2	1	0	0
Sea Star Resources Corp.	3	1	1	0
Skookumchuck Salmon Farms Ltd.	1	1	0	0
Ocean Farms Ltd.	3	2	0	0
*Suncoast Salmon Ltd.	1	0	0	0
Saltstream Engineering Ltd.	0	1	0	0
Silver Dale	0	0	1	0
Rocky Mountain Trout	0	0	1	0

Table 4. Summary of fish numbers on hand at Sunshine Coast salmon farms (n=30) in mid-August, 1986, by species and year class. Year class is based on time in saltwater, thus 1+ means between one and two years in seawater.

Species/Year Class		No. Fish on Hand mid-August 1985	Species Sub-totals
Chinook:	0+	980,726	
	1+	407,377	
	2+	7,636	
	3+ and 4+	4,910	
			1,400,649
Coho:	0+	1,352,530	
	1+	306,145	
			1,658,675
Rainbow Trout:	0+	246,630	
	1+	13,125	
			259,755
Atlantic Salmon:	0+	1,590	
			1,590
	TOTAL		3,320,669

Table 5. Number, weight and mortality estimates for smolts introduced to seawater in 1986 (0+)[3], by species and sexual modification. The number of farms reporting fish in each species/sexual modification category is given in parentheses (n=). NA = not applicable.

Species/Sexual Modification	Stocking Period 1986	Weight (gm) at Stocking		Weight (gm) at Mid-Aug/86		Total No. Stocked[1]	Total No. Remaining at Mid-Aug/86[1]	Mortality (%)		
		Mean	Range	Mean	Range			Overall[1]	Min.	Max.
Chinook										
Natural (n=18)	late May-mid-Aug	11.7	3-43	35.6	6-85	811,725	737,415	5	< 1	42
Sterile (n=1)	mid-Aug	8	NA	NA	NA	20,000	20,000	NA	NA	NA
Feminized[2] (n=8)	late Jun-mid-Aug	10.5	6-22	27.9	16-45	237,200	223,311	2.7	< 1	5-10
Coho										
Natural (n=16)	late May-mid-Aug	15.4	6-43	44.3 / 140[3]	7-180	573,740	410,735	2	< 1	5.6
Sterile (n=17)	mid May-mid-Aug	8.3 / 30[3]	4.5-40	21.9 / 112.5[3]	7-150	1,104,000	848,320	4.7	< 1	10
Feminized (n-3)	late May-mid Jul	8.1	3.8-21	41.4	7.8-75	95,000	93,475	1.6	< 1	2.25
Rainbow Trout										
Natural (n=6)	Jan-mid-Aug	24.6 / 50[4]	10-40 / NA	37.5 / 700[4]	30-140 / NA	316,074	246,630	21.5	4	90

1 Some respondents were unable to report the number of fish stocked and/or remaining at mid-August. Overall mortality was calculated using data from farms which reported both these parameters.

2 Includes one small group of masculinized females.

3 Fish which failed to smoltify when introduced to seawater in 1985, but considered 0+ for this presentation.

4 Two groups RBT were stocked in Jan-Feb 1986; the remainder were stocked between May and mid-August 1986.

Table 6. Number, weight and mortality estimates for smolts introduced to seawater in 1985 (1+), by species and sexual modification. The number of farms reporting fish in each species/sexual modification category is given in parentheses (n=). NA = not applicable or data not available.

Species/Sexual Modification	Weight (gm) at Stocking (Jun-Jul 1985)		Weight (gm) at Mid-Sep 1985		Weight (gm) at Mid-Aug 1986		Total No.[1] at Mid-Sep 1985	Total No.[1] Remaining at Mid-Aug/86	Mortality (%) Mid-Sep/85 to Mid-Aug/86		
	Mean	Range	Mean	Range	Mean	Range			Overall[1]	Min.	Max.
Chinook											
Natural (n=11)	9.4	6-15	111.7	20-250	1127	530-1,800	314,194	238,969	23.9	< 1	50
Feminized (n=6)	11.5	8-15	81.8	40-130	968	450-1,800	195,503	168,408	13.9	< 1	50
Coho											
Natural (n=8)	NA / 20[2]	NA	146.7 / 300[2]	80-200 / NA	2,310 / 4,500[2]	1,130-3,200 / NA	257,900	196,370[3]	25.5	4.8	30
Sterile (n=5)	NA	NA	132.9	60-250	1,350	1,200-1,500	135,482	109,775	19	2.4	56
Rainbow Trout											
Natural (n=4)	NA	NA	180	60-450	1,917	1,400-2,300	32,000	5,625	82.4	14.3	100
Sterile (n=1)	NA	NA	NA	NA	NA	950-1,360	15,000	7,500	50	NA	NA

[1] Some respondents were unable to report the number of fish on hand at mid-September 1985 and/or mid August, 1986. Overall mortality was calculated using data from farms which reported both these parameters.

[2] Data from one group of smolts held a full year in freshwater; the remainder are "accelerated" smolts.

[3] Some 60,200 fish reported harvested prior to mid-August 1986 are not included in this number.

Table 7. Number, weight and mortality estimates for chinook smolts introduced to seawater in 1984 (2+), 1983 (3+) and 1984 (4+) by sexual modification. The number of farms reporting fish in each category is given in parentheses (n=). NA = not applicable.

Year Class and Sexual Modification	Weight (gm at Mid Sep 1985		Weight (gm) at Mid-Aug 1986		Total No.[1] at Mid-Sep 1985	Total No.[1] Remaining at Mid-Aug/86	Mortality (%) mid-Sep 85 to Mid-Aug 86		
	Mean	Range	Mean	Range			Overall[1]	Min.	Max.
1984 (2+)									
Natural (n=2)	2,100	1,500-2,700	4,200	3,000-5,400	1,345	1,280	4.8	NA	NA
Feminized (n=4)	1,000	226-1,500	4,210	1,814-6,800	13,100[2]	6,356	5.4	< 1	8
1983 (3+)									
Natural (n=1)	3,000	NA	9,000	NA	NA	*	33	NA	NA
Feminized (n=1)	1,800	NA	9,100	NA	*	*	31	NA	NA
1982 (4+)									
Natural (n=1)	6,800	NA	13,000-15,000	NA	*	*	43	NA	NA

[1] Some respondents were unable to report the number of fish on hand at mid September 1985 and/or mid August 1986. Overall mortality was calculated from farms which reported both these parameters.

[2] A large number of these fish were sold before mid-August, 1985.

* These numbers may not be published in order to preserve commercial confidentiality.

Table 8. Number of smolts transferred to seawater in 1986 which were natural or which had been sexually sterilized or feminized, by species (Sunshine Coast area only).

	Total	Natural	Feminized	Sterilized
Chinook	1,068,925	811,725	237,200	20,000
Coho	1,772,740	573,740	95,000	1,104,000
Rainbow	316,074	316,074	0	0
Totals	3,157,739	1,701,539	332,200	1,124,000

Table 9. Number of Sunshine Coast area salmon farms reporting the purchase of vaccinated smolts in 1986, by species and disease against which protection was sought (V = vibriosis, F = furunculosis)

Chinook		Coho		Rainbow Trout	
V	V+F	V	V+F	V	V+F
11	8	15	8	3	2